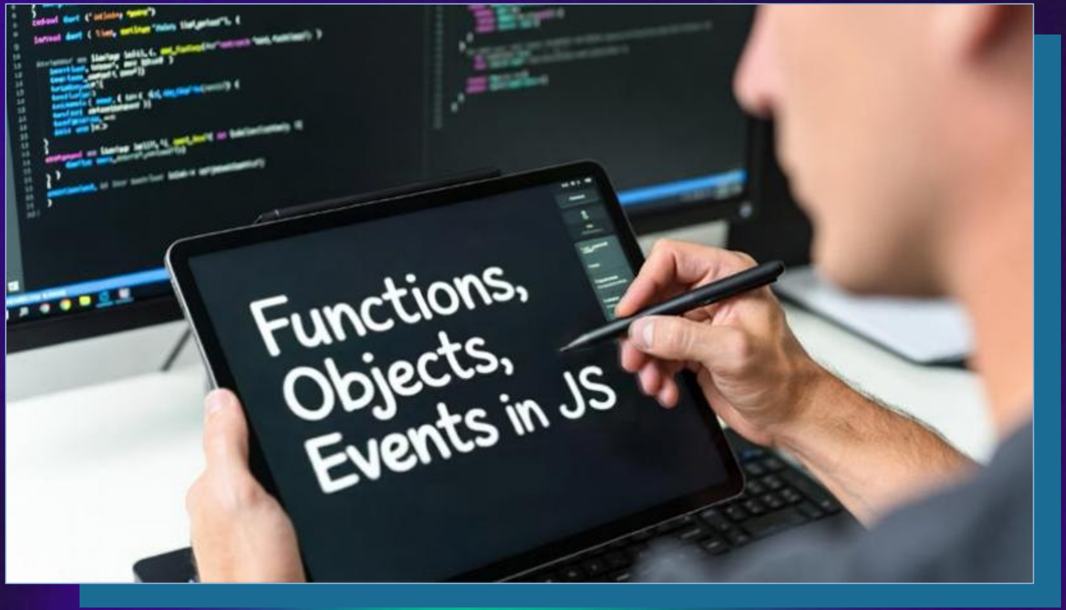
Functions, Objects, Events

Functions, Arrow Functions, Callbacks, Objects, Classes, Constructors, Methods, Events



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SoftUni AI

https://ai.softuni.bg

Agenda

1. **Functions** in JS
   - Functions, Parameters, Return Value, Defining and Invoking
   - Arrow Functions, Functions as Parameters, Callbacks
2. **Objects** in JS
   - Keeping Related Values Together
3. Intro to **Classes** in JS: Defining and Using Classes
   - Classes, Fields, Constructors, Methods
4. **Events** and **Event Handling**
   - Event Handling in HTML and JavaScript

Sli.do Code

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Breaks

20:00 / 21:00

Functions in JS

Defining and Invoking Functions, Recursive Functions, Debugging

Functions in JavaScript

- In JavaScript, a **function** is **named block of code**

```
function printHello() {
  console.log("Hello!");
  console.log("I am a function.");
}
```

- Once defined, a function can be **invoked** multiple times

```
for (let i = 1; i < 10; i++) {
  printHello();
}
```

Functions in JavaScript

- Functions can take **parameters** and **return** values

```
function calcCircleArea(radius) {
  let area = Math.PI * radius * radius;
  return area;
}
```

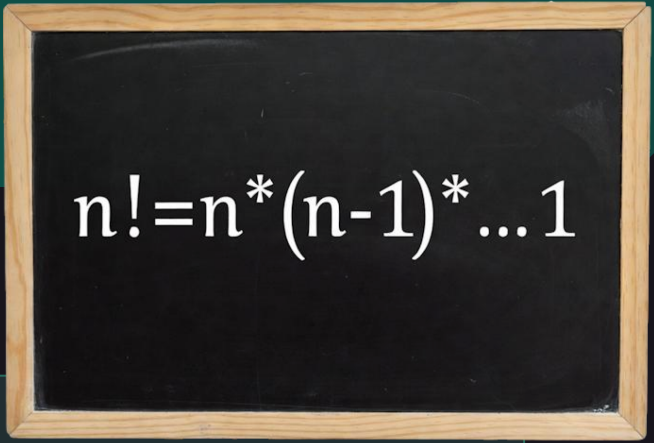
- Once defined, a function can be **invoked** multiple times with different parameters

```
console.log(calcCircleArea(5));
console.log(calcCircleArea(12.5));
```

Recursive Functions

- A function can **invoke itself** recursively:

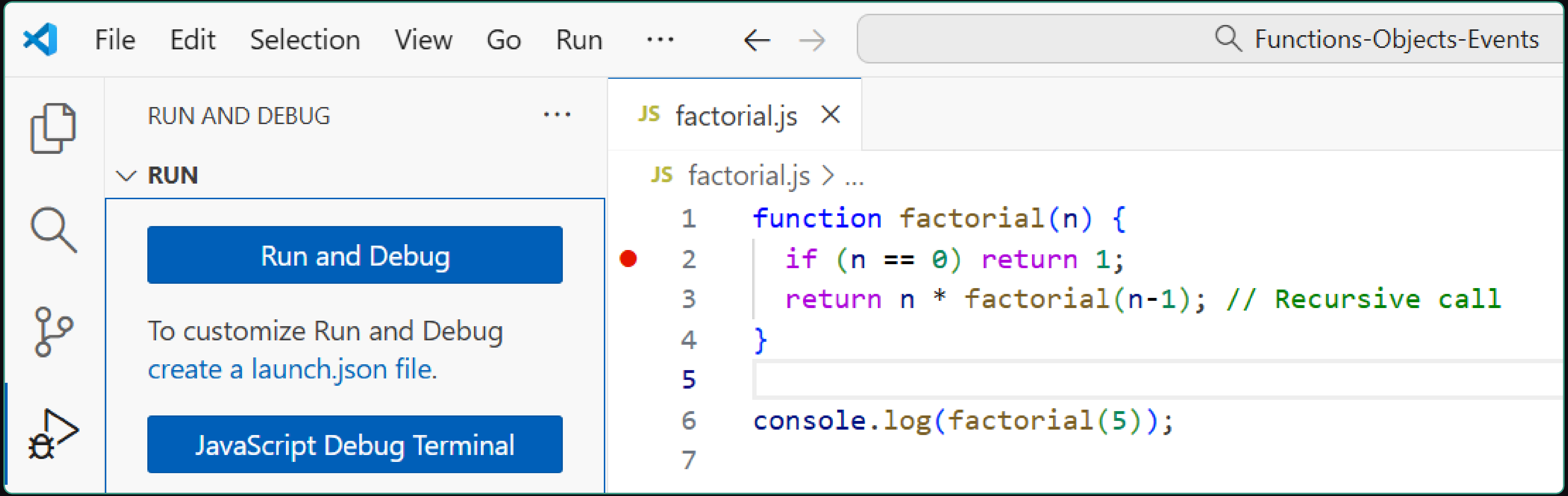
```
function factorial(n) {
  if (n == 0) return 1; // Base case
  return n * factorial(n-1); // Recursive call
}

console.log(factorial(5)); // 120
```



- **Recursion** is a powerful technique in programming
- Recursive functions should have a **base case** to avoid **infinite recursion**

Debugging & Breakpoints in VS Code

- **Debugging** == tracing the code execution to find bugs



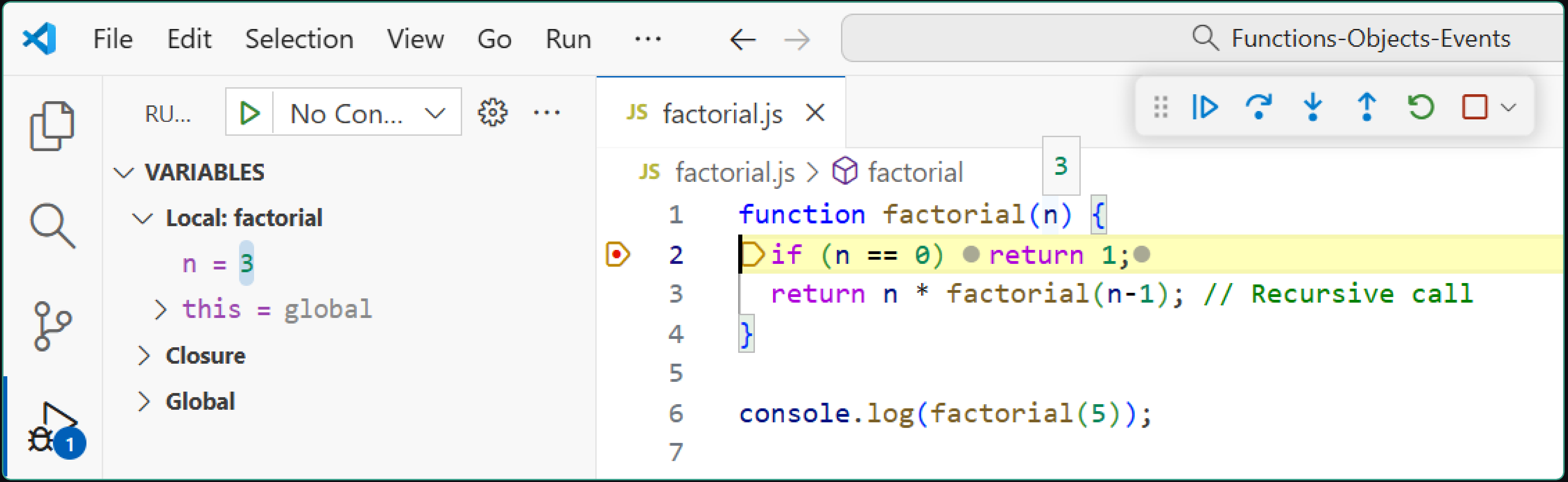
To customize Run and Debug create a launch.json file.

```javascript
function factorial(n) {
  if (n == 0) return 1;
  return n * factorial(n-1); // Recursive call
}

console.log(factorial(5));
```

- **Breakpoint** == intentional **pause-point** in the code
  - Stops the code execution to inspect the internal state

Using the VS Code Debugger

- Inspecting the internal **execution state**



VARIABLES
Local: factorial
n = 3
this = global
Closure
Global

```js
function factorial(n) {
  if (n == 0) return 1;
  return n * factorial(n-1); // Recursive call
}

console.log(factorial(5));
```

- **Watch** / modify variables, view the **call stack**
- **[F5]** → Continue, **[F10]** → Step Over, **[F11]** → Step Into

Problem: Big Factorial

- Write a JS function for **calculate n!** (factorial)
  - Ensure it works for **big inputs** (e. g. 50 factorial)
- **Solution**: we shall use **BigInt** arithmetic

```
function factorial(n) {
  if (n == 0 || n == 1) return 1n;
  return BigInt(n) * factorial(n - 1);
}
console.log(String(factorial(50)));
// 30414093201713378043612608166064768844377641568960512000000000000
```

n!

Judge link: https://alpha.judge.softuni.org/contests/functions-objects-events/5273

Variable Number of Arguments

```
function sum(...numbers) {
  let total = 0;
  for (let num of numbers)
    total += num;
  return total;
}

console.log(sum(2, 3)); // 5
console.log(sum(2, 3, 4, 5)); // 14
console.log(sum(3)); // 3
console.log(sum()); // 0
```

Variable number of arguments

for-of loop enumerates the input arguments

Problem: Incomes and Expenses

- We are given a sequence of **commands**:
  - **Income: {sum}**
  - **Spend: {sum}**
- Write a function to **process all commands** and calculate the final balance (starting with 0 initially)

```
console.log(processExpenses(
   "Income: 50", "Income: 70", "Expense: 30",
   "Income: 100", "Expense: 40", "Income: 50");
// 200
```

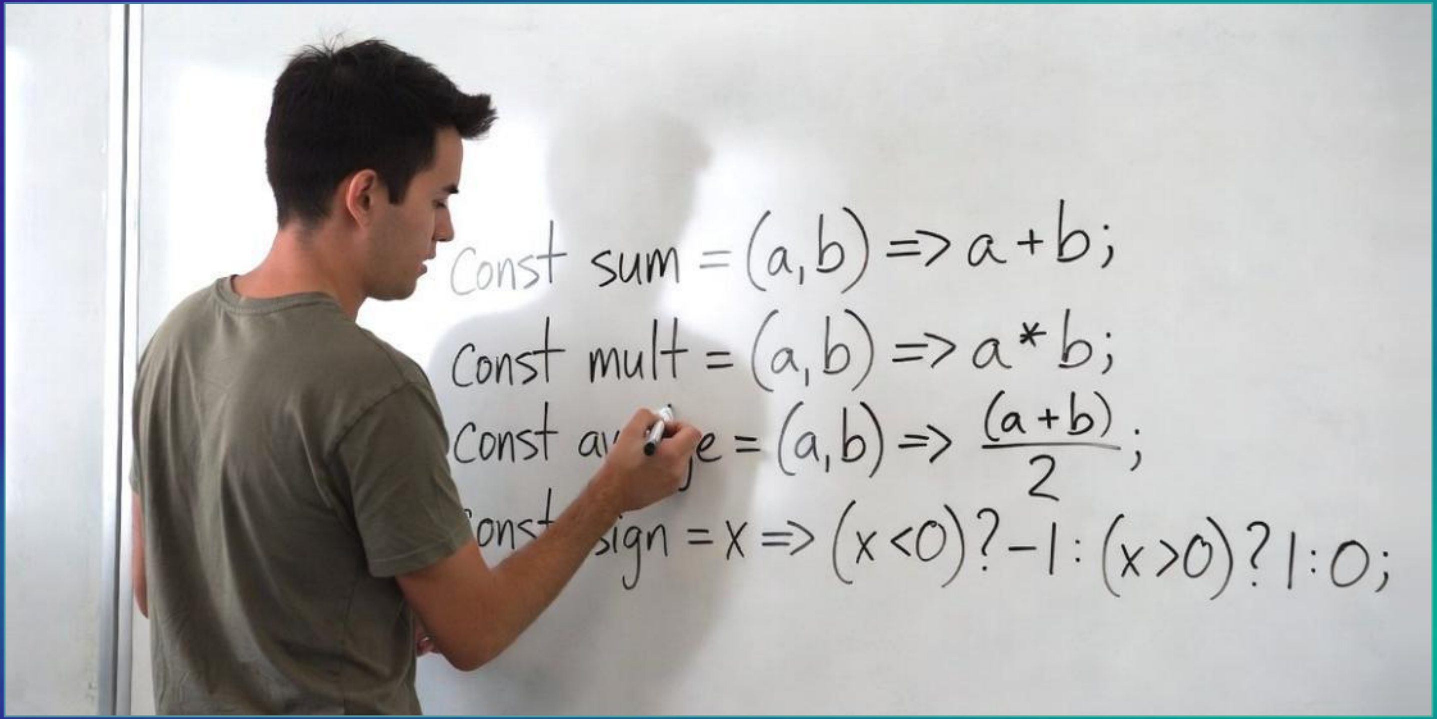
Solution: Incomes and Expenses

```
function processExpenses(...commands) {
  let balance = 0;
  for (let command of commands) {
    const [type, amount] = command.split(": ");
    const value = parseFloat(amount);
    if (type == "Income")
      balance += value;
    else if (type == "Expense")
      balance -= value;
  }
  return balance;
}
```

Judge link: https://alpha.judge.softuni.org/contests/functions-objects-events/5273

Arrow Functions

Function Expressions, Arrow Functions, Higher-Order Functions



```
Const sum = (a,b) => a+b;
Const mult = (a,b) => a*b;
Const av  ge = (a,b) => (a+b) ;
                         2
 onst  sign = x => (x<0)?-1:(x>0)?1:0;
```

Function Expressions

`f = function(…) {…}`

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- Variables can hold **values** of type "**function**"
- Defined through a **function expression**

```
const add = function(a, b) {
  return a + b;
}

console.log(add); // [Function: add]
console.log(add(2, 3)); // 5

let sum = add, sqrt = Math.sqrt;
console.log(sqrt(sum(8, 1))); // 3
```

Arrow Functions

`(x) => 2 * x`

- **Arrow functions** (lambda) use the arrow operator `=>` to provide a **shorter syntax** for function expressions:

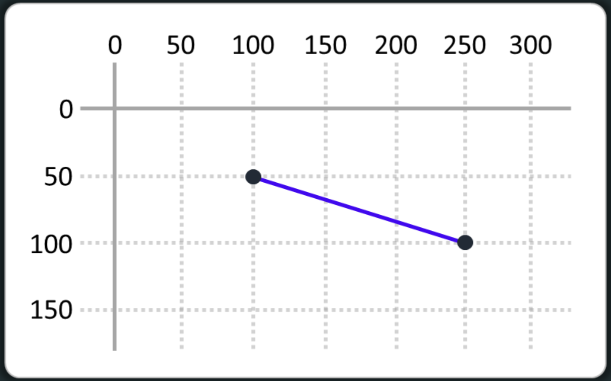
```
const sum = (a, b) => a + b;
const mult = (a, b) => a * b;
const average = (a, b) => (a + b) / 2;
const sign = x => (x < 0) ? -1 : (x > 0) ? 1 : 0;

console.log(sum(2, 5), mult(2, 5)); // 7 10
console.log(average(sum(2, 5), mult(2, 5))); // 8.5
console.log(sign(3), sign(0), sign(-4)); // 1 0 -1
```

Arrow Functions – More Examples

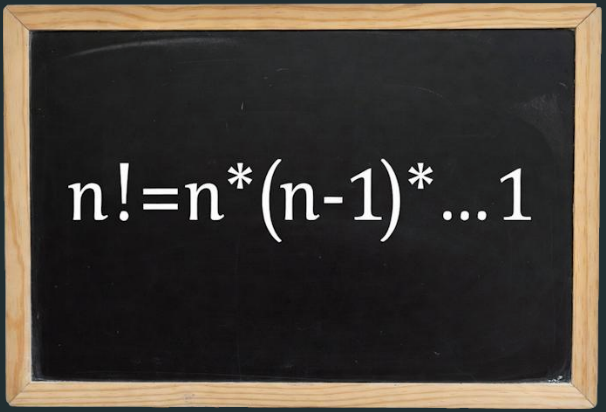
```
const distance = (x1, y1, x2, y2) =>
  Math.sqrt((x2-x1)**2 + (y2-y1)**2);

console.log(distance(100, 50, 250, 100));
// 158.11388300841898
```



```
const factorial = (n) => {
  if (n == 0) return 1;
  return n * factorial(x-1);
}

console.log(factorial(5)); // 120
```



Anonymous Functions

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- **Anonymous functions** have no name:

```
console.log(function(x) { return x * x });
// [Function (anonymous)] (unnamed function)
```

```
console.log(() => console.log("hello"));
// [Function (anonymous)] (unnamed function)
```

```
let sum = (a, b, c) => a + b + c;
console.log(sum);
// [Function: sum] (has name "sum", not anonymous)
```

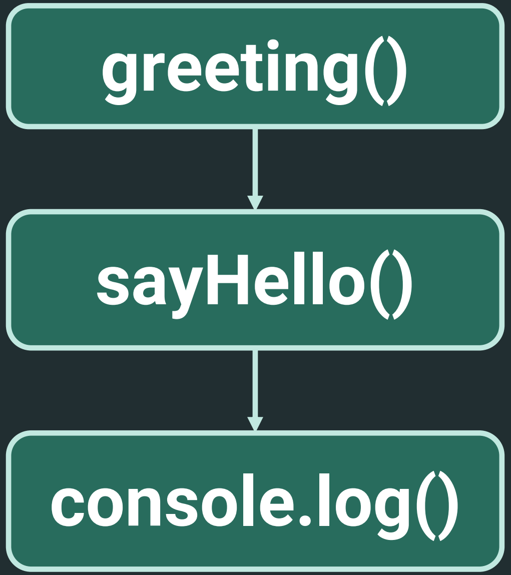
Functions as Arguments

- **Functions** can be passed as **arguments** to other functions:

```
const sayHello = () => "Hello, ";
const sayHi = () => "Hi, ";
const sayBye = () => "Bye, ";

function greeting(greetingFunc, name) {
  return greetingFunc() + name;
}

console.log(greeting(sayHello, "JS!")); // Hello, JS!
console.log(greeting(sayHi, "JS!")); // Hi, JS!
console.log(greeting(sayBye, "JS!")); // Bye, JS!
```



Higher-Order Functions

f(g(x))

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- **Higher-order functions** work by invoking other functions, passed as arguments (or return a function as a result)

```
function aggregate(start, end, operation) {
  for (var result = start, i = start+1; i <= end; i++)
    result = operation(result, i);
  return result;
}
```

```
console.log(aggregate(1, 5, (a, b) => a + b)); // 55
console.log(aggregate(1, 5, (a, b) => a * b)); // 120
console.log(aggregate(1, 5, (a, b) => '' + a + b)); // 12345
```

Problem: Special Numbers

- Write a function to return all numbers in range [start … end]
  - Divisible to **3**
  - Containing digit **2**
- Use **higher-order function**: iterate over the range in a loop and filter the range with arrow function

```
console.log(specialNumbers(20, 30));
// Nums: 21 24 27
```

```
console.log(specialNumbers(100, 200));
// Nums: 102 120 123 126 129 132 162 192
```

Solution: Special Numbers

```
function specialNumbers(start, end) {

  function generateRange(start, end, filter) {
    let result = '';
    for (let num = start; num <= end; num++)
      if (filter(num))
        result += (result ? ' ' : '') + num;
    return result;
  }

  let filterDiv3 = (num) => num % 3 == 0;
  let filterContains2 = (num) => num.toString().includes('2');
  let filters = (num) => filterDiv3(num) && filterContains2(num);

  return "Nums: " + generateRange(start, end, filters);
}
```

Judge link: https://alpha.judge.softuni.org/contests/functions-objects-events/5273

Function Returned by Function

- A **function can return another function** as output:

```
function greeting(message) {
  return function(name) {
    return message + name;
  }
}

let sayHi = greeting("Hi, ");
console.log(sayHi); // [Function: anonymous]
console.log(sayHi("Steve")); // Hi, Steve

let sayWelcome = greeting("Welcome, ");
console.log(sayWelcome("Steve")); // Welcome, Steve
```

```
f(x) => function g(x)
```

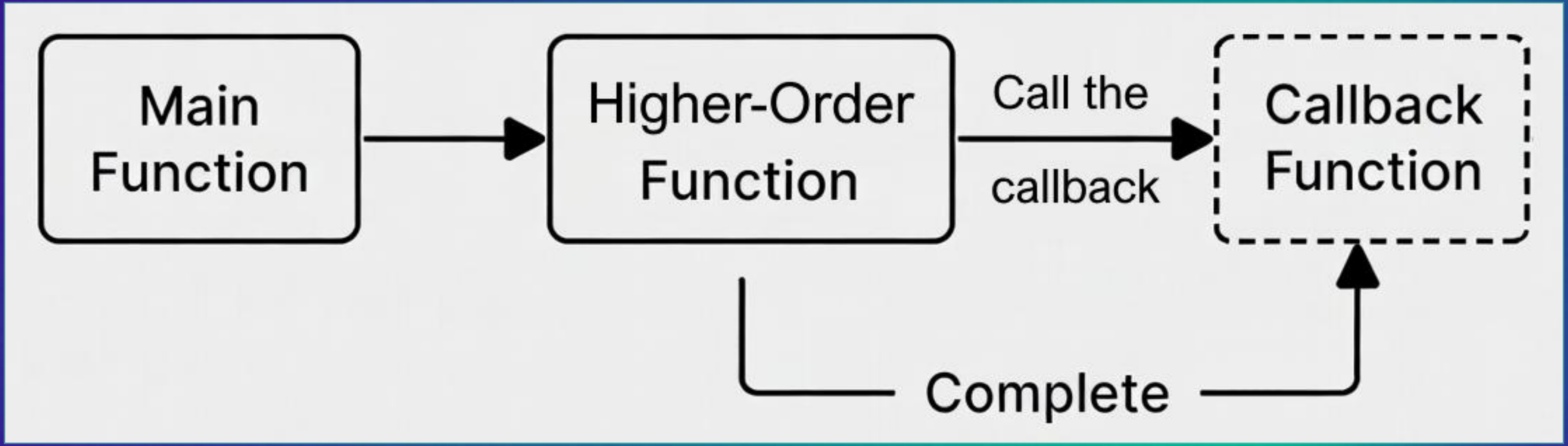
Closures

- **Closure** == function returning a function, with an **internal state**

```
function createCounter(start) {
  let count = start; // Internal state: count
  return function() {
    return count++;
  }
}
let counter1 = createCounter(100);
console.log(counter1(), counter1()); // 100 101
let counter2 = createCounter(1);
console.log(counter2(), counter2()); // 1 2
```

Callback Functions

Functions, Sent as Arguments,
Designed to be "Called Back"



Callbacks

- In programming, a **callback function** is a function, given as parameter, indented to be "***called back***"

```
function scanRange(start, end,
    onStart, onNumber, onEnd) {
  onStart(); // Invoke a callback
  for (let i = start; i <= end; i++) {
    onNumber(i); // Invoke a callback
  }
  onEnd(); // Invoke a callback
}
```

Using Callback Functions

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- Invoking a function, which requires **callback functions**:

```
scanRange(1, 3,
  () => console.log("Starting scan..."),
  (num) => console.log("Found number: " + num),
  () => console.log("Scan complete.")
);
```

```
Starting scan...
Found number: 1
Found number: 2
Found number: 3
Scan complete.
```

Built-In Callbacks in JavaScript

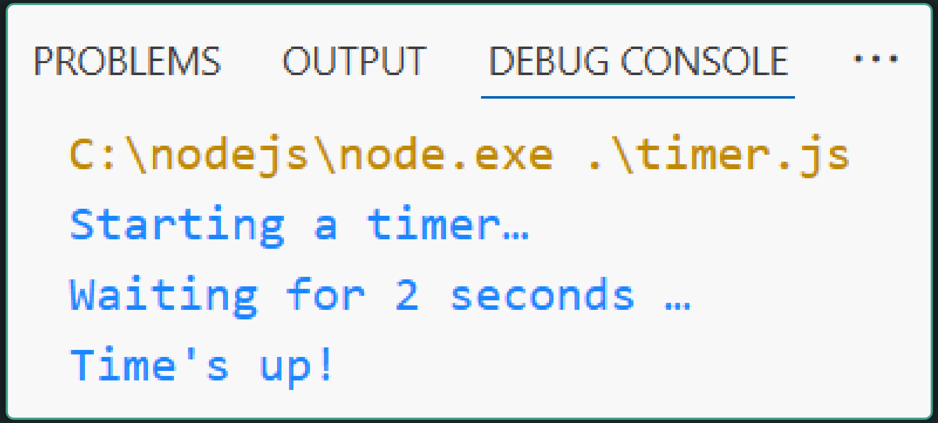
- In JavaScript **callbacks** are highly popular, for example:
  - **setTimeout(…)** will invoke a **callback** after time elapsed

```
console.log("Starting a timer…");

function timeoutCallback() {
  console.log("Time's up!");
}

setTimeout(timeoutCallback, 2000);

console.log("Waiting for 2 seconds …");
```



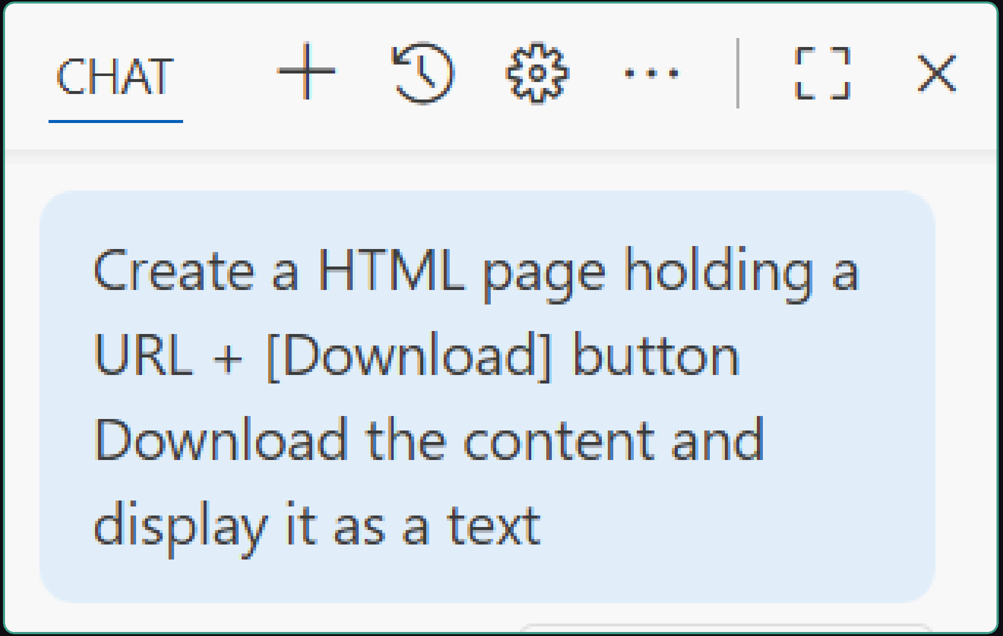
```
C:\nodejs\node.exe .\timer.js
Starting a timer…
Waiting for 2 seconds …
Time's up!
```

Real-World Callbacks in JS

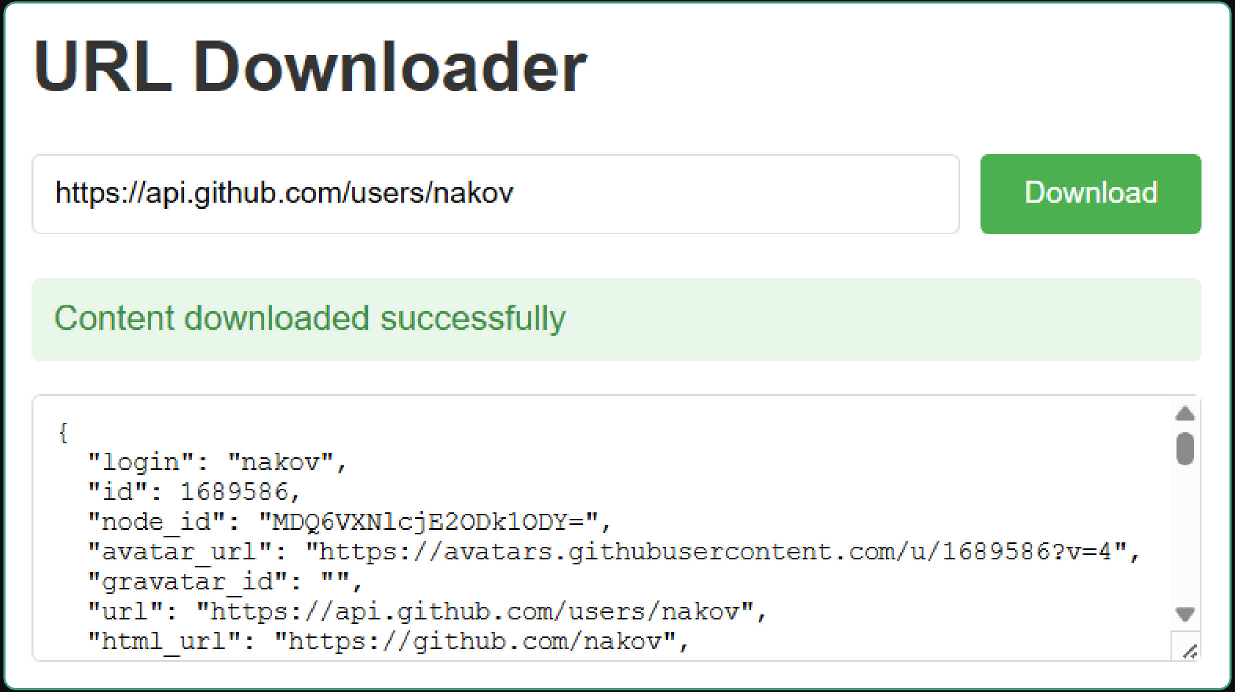
```
const https = require('https');
let request = https.get('https://softuni.org');
request.on('response', function(response) {
  let data = '';
  response.on('data', chunk => data += chunk);
  response.on('end', () => console.log(data));
});
request.on('error', function(error) {
  console.log('Network error: ' + error.message);
});
```

Problem: URL Downloader

- Create a **HTML page** holding a **URL** + **[Download]** button
  - Download the content and display it as a text
- **Solution**: prompt **Copilot**



Create a HTML page holding a URL + [Download] button Download the content and display it as a text



URL Downloader

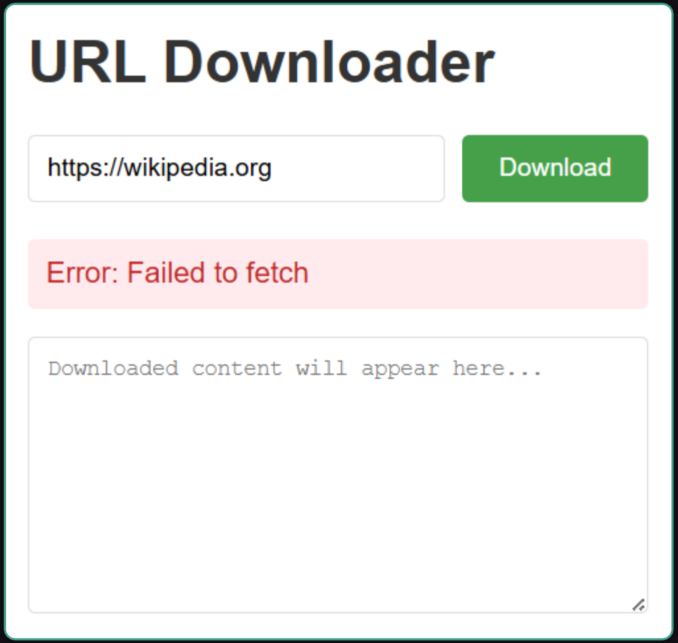
https://api.github.com/users/nakov

Content downloaded successfully

```
{
  "login": "nakov",
  "id": 1689586,
  "node_id": "MDQ6VXNlcjE2ODk1ODY=",
  "avatar_url": "https://avatars.githubusercontent.com/u/1689586?v=4",
  "gravatar_id": "",
  "url": "https://api.github.com/users/nakov",
  "html_url": "https://github.com/nakov",
```

URL Downloader Fails

- The "**URL Downloader**" app **fails** to load most Web sites:
  - Loading `**https://wikipedia.org**` → Error: Failed to fetch
- This is a **security limitation** in Web browsers: **CORS policy**


URL Downloader

https://wikipedia.org

Error: Failed to fetch

```
Downloaded content will appear here...
```

- Use CORS-enabled URL addresses, e.g.
  - https://api.github.com/users/nakov
  - https://catfact.ninja/fact
  - https://api.chucknorris.io/jokes/random
  - https://pokeapi.co/api/v2/pokemon/pikachu

Objects in JavaScript

Keeping a Set of Fields Together

person	
name	Maria
age	24
town	Sofia

```
let person = {
  name: "Maria",
  age: 24,
  town: "Sofia"
};
```

Objects in JavaScript

- **Objects** in JavaScript keep a set of values together

```
let person = {
   name: "Maria",
   age: 24,
   town: "Sofia"
};
```

person	
name	Maria
age	24
town	Sofia

```
person.age++;
console.log(`I am ${person.name}.`);
console.log(`I am ${person.age} years old.`);
```

Working with Objects

```
let person = { name: "Maria", age: 24 };
person.isStudent = true; // Add a new property
console.log(person);
// { name: 'Maria', age: 24, isStudent: true }
person.age++; // Change a property
console.log(person['age']); // Access by index → 25
delete person.isStudent; // Remove a property
console.log(person); // { name: 'Maria', age: 25 }
for (let key in person) // Loop through the object
  console.log(key + ": " + person[key]);
```

Nested Objects

Nested object: object inside another object

```
const user = {
  name: "George",
  address: { town: "Plovdiv", country: "BG" },
};
console.log(user);

user.username = "gogo98";
let job = { title: "Developer", company: "SoftUni" }
user.job = job;
user.job.title = "CTO";
console.log(user);
```

JSON

- **JSON** is a text-format for storing JavaScript objects

```
const user = {
  name: "George",
  address: { town: "Plovdiv", country: "BG" },
};
const userJSON = JSON.stringify(user);
console.log(userJSON); // userJSON is string
const colorJSON = '{"red":75,"green":89,"blue":43}';
let c = JSON.parse(colorJSON);
console.log(`RGB(${c.red}, ${c.green}, ${c.blue})`);
```

Problem: Largest Rectangle

- Write a function to take **several rectangles**, given as **JSON** and print the **largest** of them

```
printLargestRectangle(
  '{"width":30, "height":20}',
  '{"width":5, "height":120}',
  '{"width":15, "height":40}',
  '{"width":25, "height":25}',
  '{"width":35, "height":15}',
)
```

```
Largest rectangle: 25 x 25 -> area: 625
```

Solution: Largest Rectangle

```
function printLargerRectangle(...rectanglesAsJSON) {
  let largestArea = 0, largestRect = null;
  for (let rectJson of rectanglesAsJSON) {
    const rect = JSON.parse(rectJson);
    const area = rect.width * rect.height;
    if (area > largestArea)
      [largestArea, largestRectangle ] = [area, rect];
  }
  if (largestRectangle)
    console.log(`Largest rectangle: ${largestRect.width} x
      ${largestRect.height} -> area: ${largestArea}`);
}
```

Judge link: https://alpha.judge.softuni.org/contests/functions-objects-events/5273

Methods: Functions inside Objects

```
const rectangle = {
  x: 150, y: 40,
  width: 20, height: 15,
  move: function(dx, dy) {
    this.x += dx;
    this.y += dy;
  }
  calcArea() { return this.width * this.height; },
  toString() { return `Rect(${this.x}, ${this.y})`; }
}
```

Method move(dx, dy)

`this` means the object itself

Method toString()

Calling Methods of an Object

```
console.log("" + rectangle); // Invokes toString()
// Rect(150, 40)

rectangle.move(50, -10);
console.log(rectangle.toString()); // Rect(200, 30)

console.log("Area:", rectangle.calcArea()); // Area: 300

for (let i=10; i<=100; i+=10) {
  rectangle.move(i, 0);
  console.log("Rectangle moved to: " + rectangle);
}
```

Objects as Function Parameters

```
function printUser({name, address: {town, country}}) {
  console.log(`Name: ${name}`);
  console.log(`City: ${town}`);
  console.log(`Country: ${country}`);
}

const user = {
  name: "Nina",
  address: { town: "Plovdiv", country: "BG" }
};
printUser(user);
```

This syntax is called "object destructuring"

Objects as Function Result

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```
function calcStats(...numbers) {
  let [min, max, sum] =
    [Number.POSITIVE_INFINITY, Number.NEGATIVE_INFINITY, 0];
  for (num of numbers) {
    if (num < min) min = num;
    if (num > max) max = num;
    sum += num;
  }
  return { min, max, average: sum / numbers.length, sum };
}
console.log(calcStats(5, 10, 15, 20, 25));
// { min: 5, max: 25, average: 15, sum: 75 }
```

Group declaration + assignment

Return an object

Continued in part 2

Questions?

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